Advancement in Antimicrobial Resistance Management in Asia Pacific

June 2022

Executive Summary

APAC advancement in Antimicrobial Resistance (AMR) management

- **Asia Pacific (APAC) markets can be categorized as nascent, intermediate and advanced** based on their current **approaches in AMR management;** taking a holistic approach, the report elucidates the advancement in AMR management across all three pillars - human, animal and environment health, as well as coordination across the pillars

- **Nascent markets (ID, PH, MY, VN)** have made **strides in piloting stewardship initiatives and surveillance** but **lack resources to expand coverage and build infrastructure/capabilities** to use the data in clinical practices and policy making

- **Intermediate markets (HK, SG, TH, TW)** have **achieved scale for stewardship/surveillance initiatives** and have made investments to **improve infrastructure** but **lag in understanding outcomes of existing initiatives** and making investments towards innovations tackling AMR

- **Advanced markets (AU, KR) have nationwide programs with mechanisms in place to monitor progress** but poor coordination between human, animal and environment sectors is resulting in **operations and policy making to occur in siloes**

- **Key actions such as coordination of existing capabilities, review of ongoing programs, development of working mechanisms for multi-sectoral collaborations can further drive advancement** in management of AMR across APAC markets

Note: AU – Australia; HK – Hong Kong; ID – Indonesia; MY – Malaysia; PH – Philippines; SG – Singapore; KR – South Korea; TH – Thailand; TW – Taiwan; VN – Vietnam; Nascent refers to pilot stewardship/surveillance efforts, limited R&D investment, absence of regulatory/reimbursement policies to tackle AMR; Intermediate refers to regional scale stewardship/surveillance efforts, ad-hoc investment in AMR R&D, some regulatory/reimbursement policies to tackle AMR; Advanced refers to national scale stewardship/surveillance efforts, dedicated investment in AMR R&D, HTA/reimbursement reforms, regulatory policies supporting access to solutions tackling AMR

Source: AMR review; WHO; Government websites; FAO; L.E.K. research and analysis

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The Asia Pacific (APAC) region faces a growing burden of Antimicrobial Resistance (AMR) triggering responses by markets towards AMR management

Rise of AMR in APAC:

There is a growing burden of AMR with **APAC expected to account for ~50% of global annual AMR related mortality**[1] **in 2050**

Up to **62% of antibiotics in APAC are taken without prescriptions indicating inappropriate use**[2]; significantly increasing the risk of emergence of AMR-strains of bacteria

With **less than 50% of domestic waste waters being safely treated in select APAC markets**[3], soil/surface waters have been observed to be contaminated with antibiotics and AMR-strains of bacteria

Management of AMR by APAC markets:

- In response to the growing threat, **APAC markets have taken steps to tackle AMR bacteria** across three pillars: human, animal and environment health
- These include **national action plan implementation**, **antimicrobial stewardship** efforts, **AMR infrastructure** development, and **coordination between AMR pillars***
- However, the **degree of advancement in AMR management across each of these categories varies significantly across markets; thus, future actions need to be tailored** to drive progress in AMR management

*Human health, animal health and environmental health
Source: [1]AMR review; [2]Antimicrobial Resistance & Infection Control Journal; FAO; [3]OECD database; SDG database; WHO; L.E.K. research and analysis

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With varying efforts by APAC markets to tackle the rise of AMR, the degree of advancement in AMR management in the region is evaluated in this report

Objectives

The report aims to drive conversations with payers and policymakers in APAC by laying out the current state of AMR management and a proposed path to further advancement

AMR management landscape in terms of initiatives/actions by markets to tackle AMR

Categorization of markets' advancement in AMR management across the 'One Health' pillars

Opportunities for further progression towards the next stage of AMR management to emerge as 'best in class'

Geographical scope

Ten APAC markets were evaluated for advancement in AMR management across various dimensions; markets were selected to capture different levels of progress achieved to address AMR

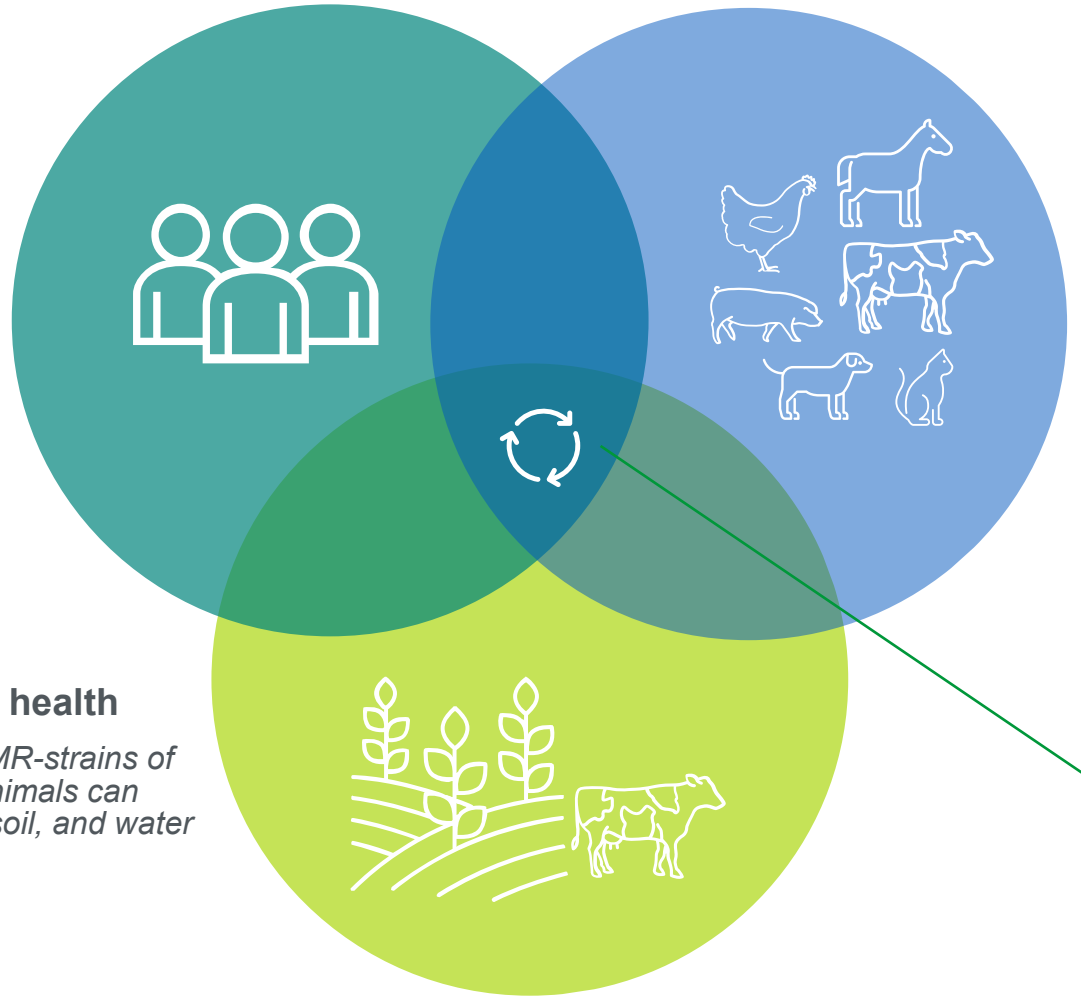
Source: WHO; L.E.K. research and analysis

Extending beyond current AMR indices, this study takes a holistic approach to acknowledge the interplay between humans, animals and the environment in impacting the spread of AMR

One Health approach – Coordination across the three AMR pillars is essential to make a significant impact in AMR management

Pillar 1: Human health

Antibiotic misuse in healthcare/community settings increases risk and spread of AMR



Pillar 2: Animal health

Need for focus on responsible use of antibiotics in animals to ensure longer term effectiveness

Pillar 3: Environment health

Indirect transmission of AMR-strains of bacteria to humans and animals can occur from food sources, soil, and water

Coordination across pillars

Interplay between humans, animals and the environment requires coordination across sectors for effective AMR management

Source: WHO; L.E.K. research and analysis

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To comprehensively arrive at each market's level of AMR advancement, indicators and sub-indicators were assessed within human, animal and environment health including coordination across pillars

A. National action plan

- Nationwide implementation of national action plan (NAP)
- Structured national action plan and strategies in alignment with WHO guidelines and OIE guidelines (only for animal health)
- Dedicated funding system for implementation

B. AMR stewardship programs

- Nationwide antibiotic monitoring system
- Stewardship initiatives to encourage prudent antibiotic use with mechanisms to measure outcomes
- Infection control programs with mechanisms to measure outcomes
- Nationwide AMR surveillance systems

C. AMR infrastructure

- Investment in R&D and push incentives
- Regulatory initiatives to support accelerated approvals to increase access to AMR therapeutics, diagnostics and vaccines
- Pull incentives or HTA/reimbursement reforms
- National Immunization Programs
- Infrastructure such as sanitation to reduce AMR spread

Coordination across pillars to ensure holistic approach to AMR management

Note: Indicators apply to human health, animal health and environment health; indicators and sub-indicators are detailed out in the appendix; WHO – World Health Organization; OIE – World Organization for Animal Health
Source: L.E.K. research and analysis

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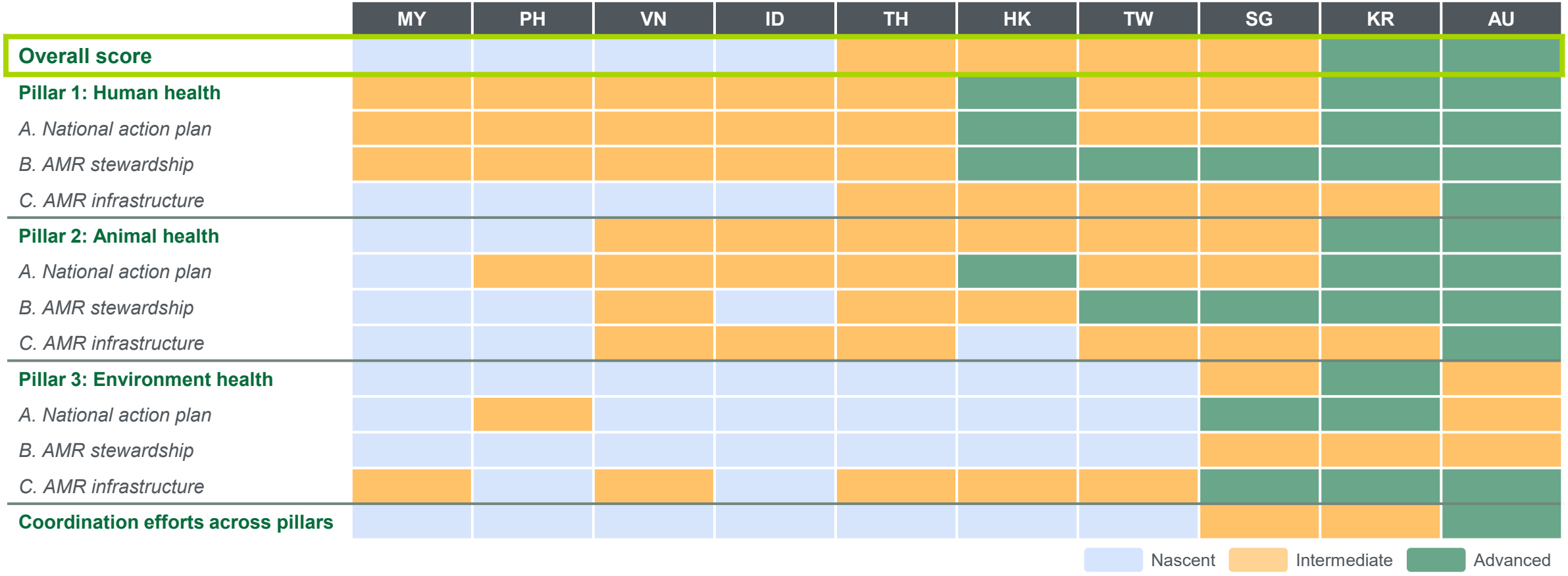
Across APAC, all markets have NAPs with some level of implementation especially in human health stewardship; implementation of animal and environment health activities is variable

Dashboard of market advancement in AMR management:



Note: AU – Australia; HK – Hong Kong; ID – Indonesia; MY – Malaysia; PH – Philippines; SG – Singapore; KR – South Korea; TH – Thailand; TW – Taiwan; VN – Vietnam; Nascent refers to pilot stewardship/surveillance efforts, limited R&D investment, absence of regulatory/reimbursement policies to tackle AMR; Intermediate refers to regional scale stewardship/surveillance efforts, ad-hoc investment in AMR R&D, some regulatory/reimbursement policies to tackle AMR; Advanced refers to national scale stewardship/surveillance efforts, dedicated investment in AMR R&D, HTA/reimbursement reforms, regulatory policies supporting access to solutions tackling AMR

Source: L.E.K. research and analysis

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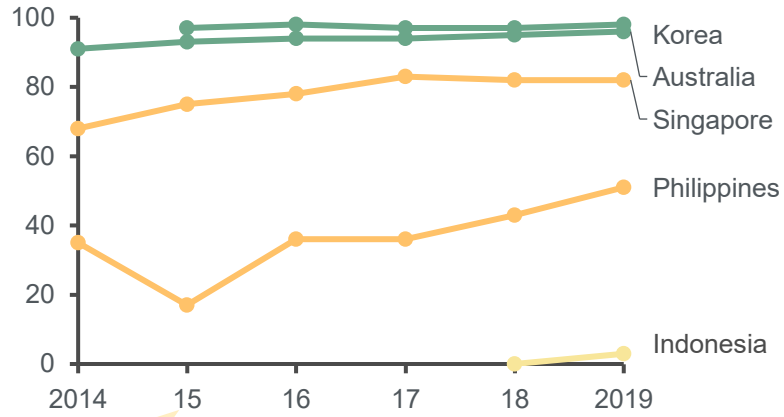
Example: Comprehensive immunization schedules progressively implemented across most APAC markets demonstrate an opportunity to use prevention to reduce need for antibiotics mitigating AMR in human health

Inclusion in national immunization program schedule by market (as of 2021):

		MY	PH	VN	ID	TH	HK	TW	SG	KR	AU
Pneumococcal	Child	✓[1]	✓		✓		✓	✓	✓	✓	✓
	Adult						✓[2]	✓[2]	✓[3]	✓[4]	✓[4]
Influenza	Child					✓	✓	✓	✓	✓	✓
	Adult		✓	✓		✓[5]	✓	✓	✓	✓	✓
Rotavirus	Child					✓[6]					✓

Pediatric pneumococcal vaccine coverage rates (three doses) by market (2014-19)
% eligible population coverage (paediatrics)



Coverage rate in Taiwan is estimated to be ~ 96% among children born after January 2015

In 2019, coverage rate in Hong Kong is estimated to be ~ 97% in children <= 5 years of age

Market classification for AMR management: Nascent | Intermediate | Advanced

Note: AU – Australia; HK – Hong Kong; ID – Indonesia; MY – Malaysia; PH – Philippines; SG – Singapore; KR – South Korea; TH – Thailand; TW – Taiwan; VN – Vietnam; [1]Introduced in 2020 thus coverage data is not available; [2]Pneumococcal vaccine is recommended for adults >= 65 years of age; [3]Adminstered to adults in the high-risk group such as immuno-comprised patients with underlying chronic illnesses; [4]Reccomended for adults >= 65 years of age. KR also offers pneumococcal vaccine to high-risk adults < 65 years; [5]Recommended for adults >= 65 years of age, high-risk individuals and pregnant women; [6]Introduced in phased or pilot setup

Source: WHO immunization data portal; Government of Hong Kong press release; Vaccines journal; L.E.K. research and analysis

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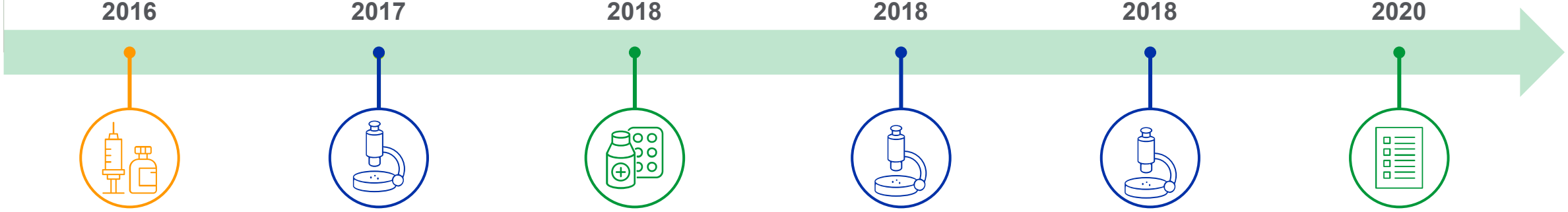
Example: For intermediate to advanced markets, progress is seen through the evolution of policies and strategies to increase access to novel AMR therapeutics and diagnostics

First NAP announced in APAC by Australia in 2015



2016	2017	2018	2018	2018	2020
Australia	**South Korea**	**Australia**	**Singapore**	**Hong Kong**	**South Korea**
Subscription model implemented for increased access to hepatitis C antivirals (though pending expansion to AMR therapeutics)	US$ 65Mn allocated to R&D for modernization of poultry and livestock management	Revised PBS listing for appropriate antibiotic use (maximum quantities and repeat prescription guidelines)	5-year National Research Foundation funding of S$ 30Mn for AMR R&D	4-8 projects annually funded by HMRF for R&D of AMR novel therapeutics and diagnostics	Exemption for economic evaluation for drugs with no alternatives (applicable to novel AMR therapeutics)

Pull incentives | Push incentives | HTA/reimbursement reforms

Note: HTA – Health technology assessment; HMRF – Health and Medical Research Fund; NAP – National action plan; PBS – Pharmaceutical Benefits Scheme
Source: Government websites, L.E.K. research and analysis

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Achievements in AMR management are notable across markets; future actions like coordination, collaboration and policy review can drive markets to further advance their AMR management

Increasing advancement in AMR management

	Nascent markets *(MY, VN, ID, PH)*	Intermediate markets *(TH, TW, HK, SG)*	Advanced markets *(SK, AU)*
NAP	**Implementation of strategies laid out in NAP** at select or **pilot sites**	**National scale implementation** of strategies laid out in NAP	**National scale implementation** of NAP along with mechanisms in place for **frequent review and reporting of progress**
Stewardship	**AMR surveillance systems** and AMU monitoring systems established for **human health**	**AMR surveillance system** and AMU monitoring systems for **human health** and **pilot initiatives for animal health**	**National scale surveillance systems** and AMU monitoring systems for **human and animal health with mechanisms to measure outcomes**
Policies	**Legislation / policies** in place discouraging inappropriate antibiotic use mainly **for animal health**	**Legislation / policies** to encourage appropriate antibiotic use in **animal health** (e.g., usage restrictions) **and human health** (e.g., hospital accreditation)	**Legislation / policies** for prudent antibiotic use in **animal and human health** along with **R&D funding** towards development of therapeutics, diagnostics and vaccines to address AMR
Vaccines	**Limited**[1] introduction of AMR-relevant vaccines as part of NIP	**Progressive expansion**[2] of coverage of AMR-relevant vaccines as part of NIP	**Comprehensive**[3] **immunization schedule** with the inclusion of AMR-relevant vaccines as part of NIP
One Health	**One Health and multi-sectoral coordination recognized** as one of the key priorities as part of NAP	**Pilot implementation of One Health initiatives** in the form of ad-hoc awareness campaigns	**Development of web-portals for data sharing** across human, animal and environment health sectors

Note: ID – Indonesia; MY – Malaysia; VN – Vietnam; PH – Philippines; TW – Taiwan; HK – Hong Kong; SG – Singapore; KR – South Korea; AU – Australia; AMU – Antimicrobial use; NAP – National action plan; NIP – National immunization program; [1]Limited refers to inclusion of any 1 of the AMR-relevant vaccines (pneumococcal, influenza or rotavirus) as part of NIP; [2]Progressive expansion refers to inclusion of any 2 of the AMR-relevant vaccines as part of NIP; [3]Comprehensive coverage refers to inclusion of all available AMR-related vaccines as part of NIP across the human life cycle. Korea is yet to include rotavirus as part of the national immunization schedule, though discussions are ongoing

Source: L.E.K. research and analysis

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In nascent markets, resource constraints largely limit coverage of initiatives; improved coordination and collaboration can strengthen AMR management strategies

Nascent markets *(MY, PH, VN, ID)*

	Present gaps	Future direction
Human health	• **Inadequate infrastructure to fulfill resource needs** for new facility development for surveillance • **Low impact of surveillance initiatives** with limited translation to clinical practices (e.g., prescription behaviour) • **Limited adoption of AMR-related vaccines** to tackle rising burden of infections	• **Coordinate the aggregation of diagnostic data** from existing diagnostic centres (e.g., standalone, in hospitals) to expand surveillance • **Train clinical personnel** (e.g., physicians, pharmacists) **to transfer insights from surveillance to clinical practices** to increase impact of existing initiatives • **Position vaccination as a complementary strategy** to tackle AMR in NAP to support introduction of AMR-related vaccines in NIP
Animal health	• **Few resources to improve nationwide AMR surveillance** in final protein products and animal health • Gaps in veterinary capacity and infrastructure	• **Collaborate with corresponding bodies in advanced APAC markets or other international bodies** to pool resources and set up surveillance and infrastructure • **Provide wide and free access to information systems** (e.g., surveillance data, guidelines) and **build veterinary capacity to reach and expand prevention and vaccination programs** to community level
Environment health	• **Limited number of systems in place to monitor AMR** in the environment • **Tendency for discharge of untreated waste** in domestic waters	• **Begin pilot monitoring of soil and water across various ecosystems** as part of nationwide surveillance • **Partner with agro-industry players to increase awareness** of antibiotic waste management
Coordination	• **Limited focus on building coordination across sectors** and few mechanisms to monitor progress	• **Establish mechanisms** (e.g., surveys, data sharing platforms) **to monitor progress** of One Health strategic plans laid out in NAP by learning from best practices in markets at advanced stages of AMR management

Note: ID – Indonesia; MY – Malaysia; PH – Philippines; VN – Vietnam; AMS – Antimicrobial stewardship; MOA – Ministry of Agriculture; MOH – Ministry of Health; NAP – National action plan; NSCC – National Surveillance Coordination Centre; NIP – National Immunization Program

Source: Ausvet website; PubMed; OIE report; Fleming fund; Government websites; L.E.K. research and analysis

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In intermediate markets, initiatives are implemented at select sites with a limited understanding of impact; expanding coverage and setting up mechanisms to measure outcomes can drive progress

Intermediate markets *(TH, HK, TW, SG)*

	Present gaps	Future direction
Human health	• **Stewardship initiatives are limited to select sites** regionally or in tertiary care settings • **Limited understanding of outcomes** of existing AMS initiatives in healthcare settings • **Slow rise in coverage of AMR-relevant vaccines** to tackle rising burden of infections	• Expand **stewardship to clinics / pharmacies** to achieve national scale AMR awareness • **Begin pilot studies** (e.g., surveys, tracking prescription data in primary care settings) **to monitor impact** of awareness campaigns • **Position AMR-relevant vaccines as a complementary strategy** in NAP and implement awareness campaigns to increase coverage as part of NIP
Animal health	• **Absence of mechanisms to measure veterinary capacity and outcomes** of existing initiatives • Antibiotic use as growth promoters is banned in many markets **but guidance on judicious antibiotic use is limited**	• **Begin pilot studies to monitor impact** of awareness campaigns (e.g., studies to correlate community awareness of antibiotic use and prescription trend) • **Demonstrate production benefits gained through use of preventive health measures** (e.g., vaccines, diagnostics, biosecurity)
Environment health	• **Poor awareness of guidelines on antibiotic waste disposal** and AMR in environment • **Limited data on AMR in environment** (e.g., soil and water bodies)	• Review NAP to ensure required structured implementation plan to tackle AMR in **environment is part of One Health Initiatives** • **Initiate periodic checks of key water bodies** to monitor for AMR and antibiotic residues to ensure guidelines are followed
Coordination	• **Awareness campaigns are siloed** or are largely led as part of global programs like World AMR Awareness Week	• **Organize coordinated awareness campaigns and programs based on learnings from global best practices** (e.g., ESBL project, antibiotic fun run) involving decision makers across human, animal and environment sectors

Note: HK – Hong Kong; SG – Singapore; TH – Thailand; TW – Taiwan; AMS – Antimicrobial stewardship; AMU – Antimicrobial use; ESBL - extended-spectrum beta-lactamase; NAP – National Action Plan, NCID – National center of infectious diseases; SFA – Singapore food authority; CDC – Centre for disease control; PCV – Pneumococcal conjugate vaccine; NIP – National immunization program

Source: Government websites; WHO; ARJC journal; MDPI; L.E.K. research and analysis

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Advanced markets have national scale initiatives, but can focus more on ensuring coordination across the pillars including reviewing policies to increase access to solutions tackling AMR

Advanced markets *(KR, AU)*		
	Present gaps	**Future direction**
Human health	• **Limited enforcement of prudent antibiotic use** in hospital and community levels • **Limited access to novel AMR therapeutics, vaccines and diagnostics** (e.g., lag between FDA approval and launch in APAC markets)	• **Offer incentives to HCPs / pharmacists** (e.g., recognition, financial benefits) to encourage prudent antibiotic use and strive for improved clinical outcomes • **Design and implement innovative pull incentives and HTA/reimbursement reforms** to increase access to AMR therapeutics, vaccines and diagnostics
Animal health	• **R&D funding in animal health is limited to ad-hoc investments** on research projects • **Limited awareness of preventive health measures** among producers	• **Collaborate with livestock producers or international bodies** to identify key needs of AMR innovation (e.g., vaccines) to allocate dedicated funding and resources for long-term projects • **Demonstrate production benefits gained through use of preventive health measures** (e.g., vaccines, diagnostics, biosecurity).
Environment health	• **Limited efforts to encourage antibiotic waste disposal** beyond healthcare or industrial settings • Absence of **established AMR surveillance system** of AMR in environment	• **Initiate programs and offer incentives** to encourage community to return unused medications and thereby ensure appropriate waste disposal • **Collate data from ad-hoc soil or water sampling studies conducted by tertiary institutions** to develop a national surveillance platform
Coordination	• **Coordination is limited across different sectors** resulting in an absence of holistic approach for policy development • **Poor communication** and siloed implementation strategies across AMR pillars	• **Develop a coordinated surveillance system leveraging existing data sharing platforms** to observe interconnected impacts across AMR pillars • **Establish multi-sectoral coordination**[1] to implement global and national level One health activities

Note: AU – Australia; KR – South Korea; FDA – Food and Drug Administration; HAI – Hospital associated infections; HCPs – Healthcare professionals; NAP – National action plan; [1]Multisectoral coordination refers to the deliberate coordination of different stakeholder groups (e.g., government, civil society, private sector) and sectors (human, animal, trade planning, finance, education and environment) to jointly achieve the goal

Source: Government websites; MOH websites; Trade press; Inter-American Development Bank report; WHO implementation handbook for NAP; L.E.K. research and analysis

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Key findings

AMR management is advancing in APAC

- APAC markets have made advancements in AMR management since the launch of National Action Plans (NAP)
- Examples of advancements include stewardship initiatives across AMR pillars, policy development in human and animal health, immunization coverage for paediatrics and adults
- All markets have a NAP with some level of implementation of strategies especially noted in human health
- NAP needs further integration of animal and environment health activities

Markets can be categorized based on advancement in AMR management

- APAC markets can be categorized from nascent to advanced based on the current progress in AMR management
- Nascent and intermediate markets are prioritizing stewardship and development of surveillance systems
- With existing systems in place, advanced markets are investing in innovation and expanding AMR infrastructure

Future actions to drive further advancement vary based on market categorization

- APAC markets can collaborate and learn from each others' successes and failures to advance the state of AMR management in the region, leveraging resources from the WHO implementation handbook for NAP on AMR
- Nascent and intermediate markets can focus on expanding across pillars or geographic scope of existing strategies in AMR pillars
- Advanced markets can prioritize coordination efforts across pillars to achieve 'best in class'

Note: NAP – National action plan; WHO – World Health Organization
Source: L.E.K. research and analysis

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Appendix: Detailed indicators

Human health: Dimensions evaluated under each performance indicator (1/2)

Indicator	Score 1 - Nascent	Score 2 - Intermediate	Score 3 - Advanced
A. National action plan			
Has the national action plan (NAP) been implemented on a national scale and is being reviewed for progress?	No/limited implementation of national action plans	Yes, the national action plan has been implemented on a national scale but there are no indications of progress being reviewed	Yes, the national action plan has been implemented on a national scale and progress is reviewed/reported (publicly) at select intervals
Is there a dedicated funding system/budget allocation in place to support the implementation of the NAP?	No/limited funding sources in place	Yes, but budget allocations are on an ad-hoc project implementation basis	Yes, there is a dedicated budget allocated for implementation of the various components of the NAP
Are the overall design and implementation plans laid out in NAP aligned with guidelines issued by WHO?	No, the NAP does not comprise of components stated in WHO guidelines	Yes, the NAP follows WHO guidelines to some extent but there are missing components	Yes, the NAP closely follows guidelines issued by WHO
B. AMR stewardship programs			
Are there antibiotic consumption monitoring systems in place?	No/limited number of systems in place (ad-hoc data gathering projects)	Yes, there are antibiotic use monitoring systems but limited implementation (e.g., at regional level or at specific hospitals)	Yes, there are antibiotic use monitoring systems with widespread implementation nationally
Are there stewardship initiatives in place to promote appropriate use (e.g., AMR awareness campaigns at hospital and community (e.g., clinics, pharmacies)) tied to measurable outcomes?	No/limited initiatives (e.g., only pilot initiatives in select regions or hospital settings)	Yes, there are initiatives in place at a nation-wide scale (e.g., in primary care settings/hospitals), but no mechanisms to measure outcomes	Yes, there are initiatives in place at a nation-wide scale (e.g., in primary care settings/hospitals) with measurable outcomes (e.g., monitoring prevalence rates, point surveys)
Are there infection control programs (e.g., systems for guidelines, monitoring and reporting of hospital acquired) in place that are tied to measurable outcomes?	No/limited infection control programs	Yes, there are infection control programs but no mechanisms to measure outcomes	Yes, there are infection control programs with mechanisms to measure outcomes
Are there AMR surveillance systems monitoring AMR incidence in hospitals/clinics that can be integrated into the globally recognized systems? (e.g., GLASS, ATLAS, JANIS)	No/limited AMR surveillance systems established	Yes, there are AMR surveillance systems but has limited coverage and is not integrated in the global system	Yes, there are AMR surveillance systems with national scale coverage with integration of data in global systems

Source: L.E.K. research and analysis

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Human health: Dimensions evaluated under each performance indicator (2/2)

Indicator	Score 1 - Nascent	Score 2 - Intermediate	Score 3 - Advanced
C. AMR infrastructure			
Are there push incentives (e.g., R&D funding systems) in place to support R&D of therapeutics, vaccines, and diagnostics?	No/limited push incentives in place	Yes, there have been ad-hoc R&D investments indicating some allocation of funding sources	Yes, there have been regular (e.g., annual) investments for push incentives
Are there regulatory initiatives to support approvals (e.g., accelerated approval, regulatory convergence, reliance mechanisms, special pathway) for therapeutics, vaccines, and diagnostics?	No/limited opportunities	Yes, there are some opportunities for accelerated approval of AMR-related products but in the absence of clear pathways	Yes, there are clearly stated opportunities/application processes for accelerated approval specifically for AMR therapeutics, vaccines, and diagnostics
Are there initiatives to improve health technology assessment (HTA)/value or improve reimbursement for AMR-related therapeutics, vaccines, and diagnostics?	No/limited reimbursement opportunities (e.g., out-of-pocket payments for outpatient settings)	Yes, reimbursements are offered but there are volume caps applied or other limitations (e.g., novel therapeutics under reserve use are not covered, generics bench-marked for pricing)	Yes, there are reimbursement provisions along with initiatives to expediate or improve HTA as part of reimbursement pathways (e.g., exemption of HTA for drugs with no alternatives/urgent market need)
Are there initiatives to adopt novel pull incentives (e.g., subscription model) related novel therapeutics, vaccines, and diagnostics?	No novel pull incentives implemented	Pilot novel pull incentives implemented (e.g., in select states)	Fully implemented pull incentive in place
Is there a National Immunization Program (NIP) in place that sufficiently reaches the target population at a national scale?	DTP3 Coverage <80% from 2015-2019; first dose of measles containing vaccine coverage <80%	DTP3 Coverage 80-89% from 2015-2019; first dose of measles containing vaccine coverage 80-89%	DTP3 Coverage >= 90% from 2015-2019; first dose of measles containing vaccine coverage >= 90%
Is the NIP based on a comprehensive approach to adult immunization?	NIP does not have include an influenza vaccination policy for any age or pneumococcal vaccination policy for adult	NIP either has an influenza vaccination policy for pneumococcal vaccination policy for adults	NIP has both an influenza vaccination policy and pneumococcal vaccination policy for adult
Does the NIP have a comprehensive pediatric schedule?	NIP pediatric schedule does not include rotavirus, pneumococcal, or influenza	NIP pediatric schedule includes one or two of the three following vaccines: rotavirus, pneumococcal, or influenza	NIP pediatric schedule includes rotavirus, pneumococcal, and influenza

Source: L.E.K. research and analysis

Animal health: Dimensions evaluated under each performance indicator (1/2)

Indicator	Score 1 - Nascent	Score 2 - Intermediate	Score 3 - Advanced
A. National action plan			
Has the national action plan (NAP) for animal health been implemented on a national scale and is being reviewed for progress?	No/limited implementation of national action plans	Yes, the national action plan has been implemented on a national scale but there are no indications of progress being reviewed	Yes, the national action plan has been implemented on a national scale and progress is reviewed/reported (publicly) at select intervals
Is there a dedicated funding system/budget allocation in place to support the implementation of the NAP?	No/limited funding sources in place	Yes, but budget allocations are on an ad-hoc project implementation basis	Yes, there is a dedicated budget allocated for implementation of the various components of the NAP
Are the overall design and implementation plans laid out in NAP aligned with guidelines issued by WHO and OIE?	No, the NAP does not comprise of components stated in WHO or OIE guidelines	Yes, the NAP follows WHO and OIE guidelines to some extent but there are missing components	Yes, the NAP closely follows guidelines issued by WHO and OIE
B. AMR stewardship programs			
Are there antimicrobial resistance organism monitoring programs or surveillance programs at national level for final protein products? Are there residue monitoring programs for final protein products?	No/limited number of systems in place (ad-hoc data gathering projects)	Yes, there are antibiotic use monitoring systems but limited enforcement measures to encourage optimal use	Yes, there are antibiotic use monitoring systems and enforcement measures to encourage optimal use
Is there legislation or guidance to encourage antimicrobial stewardship in the market?	No/limited legislation or guidance	Yes, there is legislation or guidance, but it is not specific to animal health	Yes, there is specific legislation and/or guidance to encourage antimicrobial stewardship in animal health for livestock and companion animals
Are there infection control education programs in place and implemented at a national scale by veterinary and commodity groups?	No/limited infection control education programs in place or implemented at a national scale	Yes, there are infection control education programs in place by veterinary and commodity animal groups but there is not a structure in place for implementation	Yes, there are infection control education programs in place and implemented at a national scale by veterinary and commodity groups

Source: L.E.K. research and analysis

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Animal health: Dimensions evaluated under each performance indicator (2/2)

Indicator	Score 1 - Nascent	Score 2 - Intermediate	Score 3 - Advanced
Are there AMR surveillance systems in place for livestock, companion animals, and aquaculture?	No/limited AMR surveillance systems established	Yes, there are AMR surveillance systems, but they are limited to pilot projects	Yes, there are AMR surveillance systems with national scale coverage for livestock, companion animals and aquaculture
Are there regulations defining the therapeutic use of antibiotics in animals (for prevention, treatment and control of illness caused by bacteria)?	No regulations in place defining the therapeutic use of antibiotics in animals	Antibiotics are not permitted for growth promotion in livestock but there are not regulations defining therapeutic use of antibiotics in animals	Antibiotics are not permitted for growth promotion in livestock and there are regulations defining therapeutic use of antibiotics in livestock, companion animals and aquaculture
Are there regulations requiring strict adherence to antibiotic labels for administration of, and withdrawals from, antibiotics prior to livestock being utilized for protein (milk, meat, and eggs)?	No/limited regulations requiring adherence to antibiotic labels for administration and withdrawal of antibiotics	There are regulations requiring strict withdrawal from antibiotics but not strict adherence to product labels	There are regulations requiring strict adherence to antibiotic labels for administration of, and withdrawals from, antibiotics prior to livestock being utilized for protein
C. AMR infrastructure			
Have there been recent investments to strengthen existing infrastructure and foster AMR R&D (e.g., therapeutics, vaccines, diagnostics, etc.)?	No/limited funding systems in place	Yes, there have been ad-hoc investments indicating some allocation of funding sources	Yes, there have been regular (e.g., annual) investments to improve AMR infrastructure/R&D
Are there incentives being offered by the public sector to encourage proactive health measures in livestock farming (e.g., provision of vaccines, robust biosecurity)?	No/limited incentives offered	Yes, there are incentives but part of pilot projects	Yes, there are incentives offered as part of regulatory frameworks
Have there been established working mechanisms between the market and multilateral institutions to coordinate antimicrobial stewardship efforts in animals?	No/limited coordination between market and multilateral institutions	Market is represented in multilateral institution but does not coordinate on antimicrobial stewardship infrastructure	Market has an established working mechanism with multilateral institutions (OIE, WHO, Codex) to coordinate antimicrobial stewardship efforts in animals

Source: L.E.K. research and analysis

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Environment health: Dimensions evaluated under each performance indicator (1/2)

Indicator	Score 1 - Nascent	Score 2 - Intermediate	Score 3 - Advanced
A. National action plan			
Is environment health explicitly stated or laid out as a separate pillar in the NAP?	No/limited mention of environment health in national action plan (e.g., only as part of the OneHealth efforts without details on implementation or governance)	Yes, environment health explicitly mentioned in the NAP with implementation plans but without distinct governance	Yes, environment health is laid out as a separate pillar in NAP with details on governance and implementation
Is there a dedicated funding system/budget allocation for environment health in the NAP?	No/limited funding sources in place	Yes, but budget allocations are on an ad-hoc project implementation basis	Yes, there is a dedicated budget allocated for implementation of the various components of the NAP
Are the strategies and execution plans for environment health laid out in NAP aligned with guidelines issued by WHO?	No, the NAP does not comprise of components stated in WHO guidelines	Yes, the NAP follows WHO guidelines to some extent but there are missing components	Yes, the NAP closely follows guidelines issued by WHO
B. AMR stewardship programs			
Are there antibiotic waste disposal (direct from industries or through animal feces) monitoring and enforcement programs implemented on a national scale?	No/limited programs have been implemented	Yes, programs have been implemented only in certain regions	Yes, programs implemented on a national scale
Are there AMR surveillance systems (monitoring AMR incidence in soil and water) that can be integrated into the global recognized systems? (e.g., GLASS)	No/limited AMR surveillance systems established	Yes, there are AMR surveillance systems but cannot be integrated in global system	Yes, there are AMR surveillance systems that can be/is integrated in global systems

Source: L.E.K. research and analysis

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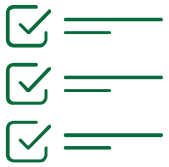
Environment health: Dimensions evaluated under each performance indicator (2/2)

Indicator	Score 1 - Nascent	Score 2 - Intermediate	Score 3 - Advanced
C. AMR infrastructure			
Have there been recent investments to strengthen existing infrastructure and foster AMR R&D (e.g., monitoring, waste management)?	No/limited funding systems in place	Yes, there have been ad-hoc investments indicating some allocation of funding sources	Yes, there have been regular (e.g., annual) investments to improve AMR infrastructure/R&D
Is there adequate local wastewater treatment for the population?	Limited treatment; direct discharge of human waste (e.g., <50% safely treated domestic waters)	Yes, some primary treatment with disinfection (e.g., 50-90% safely treated domestic waters)	Yes, extensive secondary/tertiary treatment in compliance with national standards (e.g., >90% safely treated domestic waters)
Is there easy access to clean drinking water?	No/limited access to clean drinking water	Yes, but not reliable access to all regions	Yes, reliable access to clean drinking water for all populations (e.g., >90% access to clean water on premises)

Source: L.E.K. research and analysis

Coordination across pillars: Dimensions evaluated under each performance indicator

Indicator	Score 1 - Nascent	Score 2 - Intermediate	Score 3 - Advanced
C. AMR infrastructure			
Are there AMR surveillance systems implemented across 3 pillars on a national scale, with coordination across relevant sectors?	No, efforts are limited or are pending implementation	Yes, but implementation is at a regional scale with some communication across sectors	Yes, coordinated efforts have been implemented on a national scale
Are there AMR awareness campaigns that cover the 3 pillars on a national scale?	No/limited, awareness campaigns are siloed	Yes, but awareness campaigns for 2 of the pillars are conducted cohesively with communication channels	Yes, One Health awareness campaigns have been established



Scoring across all discussed indicators will be averaged to derive an overall score which will be used as the basis to categorize advancement of markets across nascent, intermediate and advanced

Source: L.E.K. research and analysis

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